PHY 140Y - FOUNDATIONS OF PHYSICS
2000-2001
Term Test #1
Thursday, October 26, 2000
6:30 PM - 8:30 PM

INSTRUCTIONS:

Please give your name, student number, and TA's name on ALL examination booklets used.
Answer ALL questions. Total marks = 100.
Marks, shown in brackets, will be given for workings and units as well as for final answers.
[Non-]programmable calculators may be used. No aid/crib sheets are allowed.

Constants: $g = 9.81\ m/s^2$

QUESTIONS:

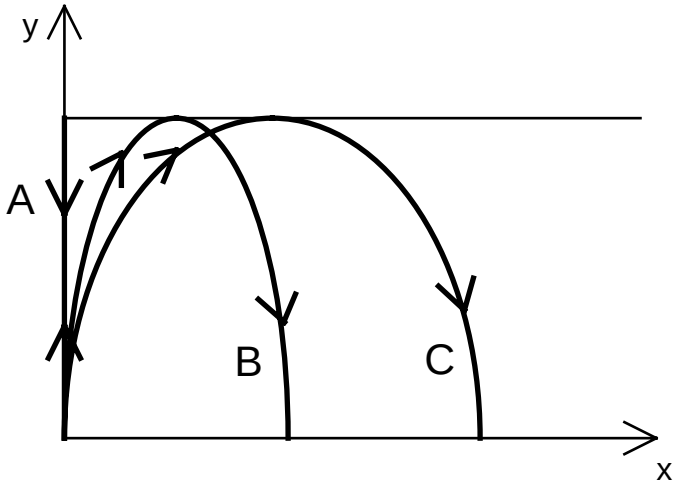
1. Give BRIEF answers to each of the following. ***[5 marks each for 20 total]***

(a) Define and briefly explain the difference between uniform circular motion and nonuniform circular motion. Give one example of each.

(b) While out for a stroll in the rain, why would you tilt your umbrella in the direction you are moving to keep drier? Include a sketch in your answer.

(c) Three fleas have a jumping contest and discover to their amazement that they each jump to the same elevation above the floor but land in different positions horizontally, as shown in the figure below. For each of the following questions, very briefly explain your reasoning. There is no need to derive equations.

(i) Which flea (A, B, or C) had the greatest initial speed?
(ii) Which flea was in the air for the longest time?
(iii) Which flea had the greatest magnitude of the acceleration while in flight?
(iv) Which flea had the greatest magnitude for the horizontal component of velocity?
(v) Which flea had the greatest magnitude for the vertical component of velocity?

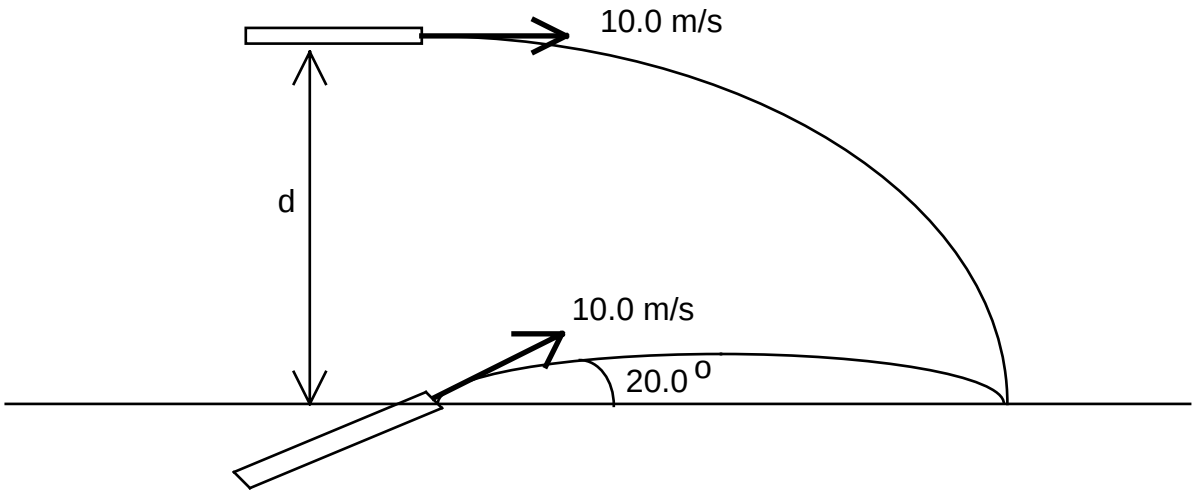


(d) You drive a car quite fast to the left around a circular turn and your passenger comments: "Gosh, feel that centrifugal force!" Using Newton's Laws, explain what force(s) the passenger senses. Is the total force on the passenger centripetal or centrifugal (away from the centre of the circle)? Explain.

[Each of the following five questions is worth 16 marks.]

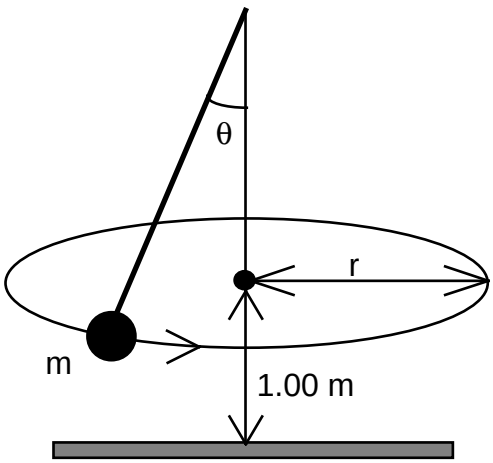
2. You accidentally drop a peanut from a tower when t = 0 s. Oops. One second (1.00 s) later, you decide that another peanut deserves the same treatment, and drop it too from the tower with zero initial speed.
(a) Sketch on a single graph the speeds of the peanuts as functions of time.
(b) While the peanuts are in flight, do they stay the same distance apart? Explain why or why not.
(c) What is the distance between the peanuts when t = 3.00 s?
(d) If the height of the tower is 92.0 m, at what time does the first peanut reach the ground? At what time does the second peanut reach the ground?

3. Two identical pea shooters fire peas with an initial speed of 10.0 m/s. The pea shooters are located a distance d apart, as shown in the figure below. The lower pea emerges from the shooter at an angle of 20.0° to the horizontal, while the upper pea emerges horizontally. The peas both hit a target at the same point.
   (a) Express the horizontal range of the upper pea in terms of the height d.
   (b) What is the horizontal range of the lower pea?
   (c) What is the value of d?

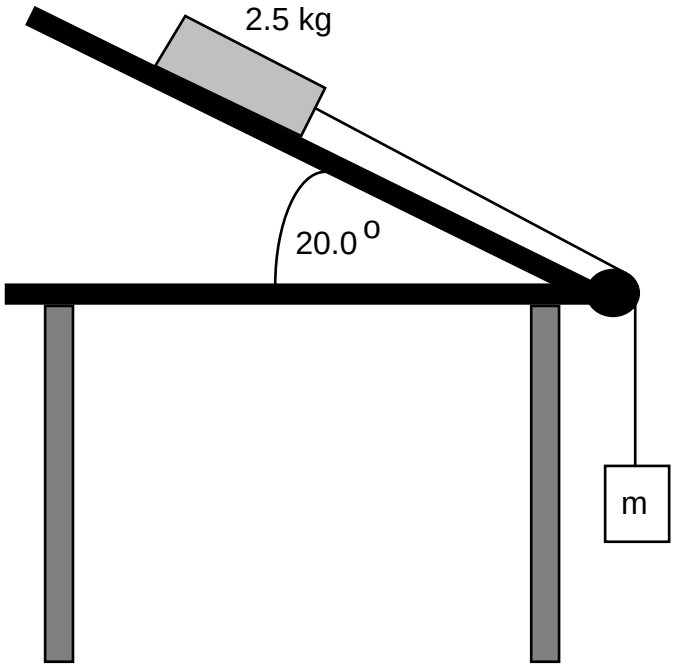


4. You head directly across a straight river of width 100. m, swimming at a speed of 1.5 m/s relative to the water. You arrive at the opposite bank having been swept downstream a distance of 50.0 m.
   (a) How long does the journey take?
   (b) What is the speed of the current?
   (c) What is your speed relative to the ground?
   (d) At what angle with respect to the upstream direction should you have headed to go straight across the river without slipping downstream? Include a sketch in your answer.

5. You are swinging a mass m at speed v around on a string in a circle of radius r whose plane is 1.00 m above the ground as shown in the figure below (on page 4). The string makes an angle θ with the vertical direction.
   (a) Define a coordinate system and draw the force diagram showing all forces acting on the mass at a particular instant in its motion. Indicate the direction to the centre of its circular path.
   (b) What is the direction of the acceleration of the mass?
   (c) Use Newton's Second Law to show that: $\tan\theta = \frac{v^2}{rg}$.
   (d) If the angle θ = 47.4° and the radius of the circle is 1.50 m, find the speed of the mass.
   (e) If the mass m = 1.50 kg, then what is the magnitude of the tension in the string?
   (f) The string breaks unexpectedly when the mass is moving exactly eastward. Where does the mass hit the ground?



6. An ideal physics textbook of mass 2.5 kg is placed on a rough plane inclined at 20.0° to the horizontal as shown in the figure below. The coefficients of static and kinetic friction between the book and the surface of the plane are 0.30 and 0.20 respectively. An ideal (massless) string is attached to the text and passes over an ideal pulley to another mass m.
   (a) Sketch a force diagram for the textbook, indicating all forces acting on the textbook.
   (b) Sketch a similar force diagram for mass m.
   (c) What is the maximum mass m that can be attached to the string before the text starts to slip?
   (d) If m = 10.0 kg, then what is the magnitude of the acceleration of the textbook?



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